CLAIMS

1. A method of substantially continuously optimising a stochastic parameter ϑ that characterises the instantaneously prevailing readiness with which crop is processed in a harvesting machine, including the step of recursively calculating the optimised parameter value in accordance with the following algorithm:

$$\hat{\vartheta}(t) = f(\hat{\vartheta}(t-1), \varepsilon(t, \hat{\vartheta}(t-1))) \qquad \text{- (A)}$$

wherein:

$\hat{\vartheta}(t)$ is the optimised stochastic parameter value at time t; and

$\varepsilon(t, \hat{\vartheta}(t))$ is an error prediction function.

2. A method according to claim 1, characterised in that the algorithm (A) has the form:

$$\hat{\vartheta}(t) = f\left(\hat{\vartheta}(t-1), \ldots, \hat{\vartheta}(t-n_{\vartheta}), \varepsilon(t), \ldots, \varepsilon(t-n_{\varepsilon}), t\right)$$

3. A method according to Claim 1 or 2, characterised in that the algorithm (A) has the form:

$$\hat{\vartheta}(t) = \hat{\vartheta}(t-1) + \gamma(t) r^{-1}(t) \psi\left(t, \hat{\vartheta}(t-1)\right) \varepsilon\left(t, \hat{\vartheta}(t-1)\right)$$

wherein:

$\gamma(t)$ is a gain term;

$r(t)$ is a scalar approximation of a Hessian $V''(\vartheta)$ in which V is a quadratic error criterion;

$\psi(t, \vartheta) = \dfrac{d\hat{y}(t, \vartheta)}{d\vartheta}$, in which $\hat{y}(t, \vartheta)$ is an estimation of a value indicative of the effectiveness of crop processing in said harvesting machine, said estimation being based on stochastic parameter ϑ; and

$\varepsilon(t, \hat{\vartheta}(t-1))$ is the difference between the actual effectiveness value *y(t)* and the estimated value $\hat{y}(t, \vartheta)$ based on the previously optimised parameter

$\hat{\vartheta}(t-1)$.

4. A method according to Claim 3, characterised in that the algorithm (A) includes an estimation of $r(t)$ that is weighted to reduce the influence, on the optimised parameter values $\hat{\vartheta}$, of past measurements.

5. A method according to Claim 3 or 4, characterised in that:

said stochastic parameter ϑ is usable in a model for the relation between a value *u(t)* indicative of the feedrate of crop into the harvesting machine and a value *y(t)* indicative of the effectiveness of an operation processing said crop in said harvesting machine; and

said value $\hat{y}(t,\vartheta)$ is an estimation value of the effectiveness obtained by the application of said model to the feedrate values *u(t)*.

6. A method according to Claim 5, characterised in that said model comprises an exponential function.

7. A method according to Claim 6, characterised in that said model has the form:

$$\hat{y}(t,\vartheta) = \exp(\vartheta u(t)) - 1 \qquad \text{- (B)}$$

8. A method according to any of the Claims 5 to 7, characterised in that:

said crop processing comprises separating useable crop parts from other plant matter; and

said value *y(t)* is indicative of a flow of useable crop losses in a selected part (13/14) of the harvesting machine.

9. A method according to any of the Claims 5 to 7, characterised in that:

said crop processing operation comprises separating useable crop parts from other plant matter; and

said value *y(t)* is indicative of a flow of return crop in a selected part (15) of the harvesting machine.

10. A method of operating a harvesting machine comprising the steps of:

(i) substantially continuously optimising a stochastic parameter ϑ that characterises the instantaneously prevailing readiness with which the harvesting machine processes crop;

(ii) substantially continuously adjusting a performance variable of the harvesting machine in dependence on the instantaneous, optimised value $\hat{\vartheta}$ of the said parameter in order to optimise the load of the harvesting machine so as to keep a value $y(t)$ indicative of the effectiveness of said harvesting machine below a predetermined value.

11. A method according to Claim 10, characterised in that:

processing the crop comprises separating useable crop parts from other plant matter;

optimising the load of the harvesting machine comprises optimising the feedrate $u(t)$ of crop into the harvesting machine; and

the effectiveness value comprises losses $y(t)$ of useable crop parts.

12. A method according to Claim 10 or 11, characterised in that the step (i) includes carrying out the method steps of any of the Claims 1 to 9.

13. A method according to any of the Claims 10 to 12, characterised in that the step (ii) of adjusting a performance variable of the harvesting machine occurs in dependence on the output of an inverted form of a yield loss estimation function:

$$\hat{y}(t,\vartheta) = \exp(\vartheta u(t)) - 1 \qquad \text{- (B)}$$

14. A method according to any of the Claims 10 to 13, characterised in that adjusting a performance variable comprises adjusting the travel speed of said harvesting machine or the actual cutting width of a header of said harvesting machine.

15. A method of mapping one or more field lots for variations in a stochastic

parameter ϑ that characterises the instantaneously prevailing readiness with which crop is processed in a harvesting machine, the method comprising the steps of:

(i) operating a harvesting machine to harvest crop in a said field lot;

(ii) simultaneously measuring the machine load and the machine effectiveness and determining the position of the machine in the field lot;

(iii) storing data indicative of the position of the harvesting machine at time t;

(iv) using the measured machine load data $u(t)$, and machine effectiveness data $y(t)$ in an optimisation of the said parameter ϑ; and

(v) mapping the optimised parameter values $\hat{\vartheta}$ obtained from step (iv) so as to produce a parameter map of the field lot.

16. A method according to Claim 15, characterised in that the step (iv) includes carrying out an optimisation according to any of the Claims 1 to 9.

17. A method of operating a harvesting machine comprising the steps of:

(i) substantially continuously optimising a stochastic parameter ϑ that characterises the instantaneously prevailing readiness with which the harvesting machine separates useable crop parts from other plant matter;

(ii) sending a display signal, that is indicative of the instantaneous parameter value $\hat{\vartheta}$, to a display device.

18. A method according to Claim 17, characterised in that the step (i) of optimising a stochastic parameter ϑ includes carrying out the method of any of the Claims 1 to 9.

19. A method according to Claim 17 or 18, characterised in that the display signal indicates an abnormal parameter value $\hat{\vartheta}$.

20. Methods according to any of the preceding claims, characterised in that said harvesting machine is a combine harvester and the crop is a grain-bearing plant.

21. Methods according to Claim 8 or 9 or to any other Claim referring thereto, characterised in that the said selected part of the harvesting machine is selected from:

the straw walkers (13);

the rotary separator;

the sieves (14);

the grain elevator;

the return flow system (15);

the cleaning section; or

the axial threshing and separating rotor;

of a combine harvester.